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(71) Applicant: SUMITOMO RUBBER INDUSTRIES LTD.
Hyogo-ken (JP)

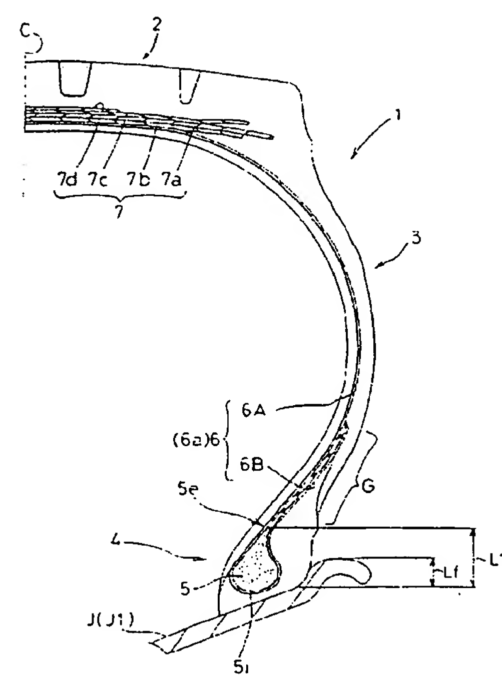
(72) Inventors:
- Ueyoko, Kiyoshi
Kobe-shi, Hyogo-ken (JP)
- Minagawa, Yasuhisa
Akashi-shi, Hyogo-ken (JP)

(74) Representative: Stewart, Charles Geoffrey
Technical,
Dunlop Tyres Ltd.,
Fort Dunlop
Erdington, Birmingham B24 9QT (GB)

(54) **Pneumatic tyre**

(57) A pneumatic tyre comprises a bead apex (5) disposed in each bead portion (4), and a carcass ply (6) extending between the bead portions and turned up in each bead portion (4) so as to wrap the bead apex (5) therein, the bead apex (5) being made of a hybrid material which is compounded from rubber, synthetic resin and short fibre at least. Preferably, the short fibre has an average diameter of 0.01 to 0.20 mm and an average length of 1.0 to 10.0 mm, and the proportion of the short fibre is 3 to 15 parts by weight with respect to 100 parts by weight of the rubber. The hybrid material has a 100% modulus of at least 10.0 MPa, a tensile strength of at least 10.0 MPa, a breaking elongation EB of at least 200 %, a Mooney viscosity of from 30 to 50 ML1+4, and a scorch time (t10) of at least 20 minutes. Optionally, a reinforcing cord layer (8) embedded in the bead apex (5) or a bead core (20) disposed immediately radially inside the bead apex is used.

Fig.1



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Description

[0001] The present invention relates to a pneumatic tyre in which the occurrence of voids in the bead portions is controlled and bead durability is improved.

[0002] In a pneumatic tyre, as shown in Fig. 6(A), in each bead a carcass (a) is turned up around a bead core (b) to be secured thereto, and a bead apex rubber (c) is positioned between a ply main portion (a1) and the ply turnup portion (a2) thereby ensuring the necessary bead rigidity.

[0003] In conventional heavy duty tyres for trucks, buses and the like, the volume of the bead apex rubber (c) is increased to increase the bead rigidity and thereby to improve bead durability.

[0004] On the other hand, in recent years, a bead structure has been proposed for weight reduction of the tyre. Fig. 6(B) shows such a bead for reducing tyre weight while improving bead durability. In this technique, contrary to the above, the volume and height of the bead apex rubber (c) are greatly decreased, and the height of a ply turnup portion (a2) is increased so that the ply turnup portion (a2) adjoins the ply main portion (a1). (Hereinafter such a structure is referred to as a new bead structure).

[0005] In this new bead structure, the bead apex rubber (c) requires higher strength and higher rigidity than in the conventional structure. Therefore, the carbon black and/or crosslinking agent are increased. However, when the amount of carbon black is increased, rubber flow during vulcanising of the tyre becomes insufficient because of the very high viscosity of the uncured rubber, and, in the vulcanised tyre, voids are liable to occur near the radially outer end (e) of the bead apex rubber (c). When a large amount of crosslinking agent is added the quality of the product tends to be impaired because rubber scorching tends to occur during extruding the rubber.

[0006] In the new bead structure, further, the height (h) is set as small as possible for the bead durability.

[0007] However, as the degree of bending of the carcass ply turnup portion (a2) occurring below the adjacent region (g) is greatly increased due to the decreased bead apex rubber volume, its spring-back force during vulcanisation is strong, and thus the tendency for the occurrence of voids is further increased as the height (h) is decreased.

[0008] It is therefore, an object of the present invention to provide a pneumatic tyre in which occurrence of voids can be effectively controlled, without hindering the weight reduction and the improvement in bead durability.

[0009] According to the present invention, a pneumatic tyre comprises a tread portion, a pair of sidewall portions, a pair of bead portions, a bead apex disposed in each bead portion, and a carcass ply extending between the bead portions and turned up in each bead portion so as to wrap the bead apex therein, wherein the bead apex comprises a hybrid material compounded from rubber, synthetic resin and short fibre at least.

[0010] Preferably, the short fibre has an average diameter of 0.01 to 0.20 mm and an average length of 1.0 to 10.0 mm, and the proportion of the short fibre is 3 to 15 parts by weight with respect to 100 parts by weight of the rubber. Preferably the hybrid material has a 100% modulus of at least 10.0 MPa, a tensile strength of at least 10.0 MPa, a breaking elongation EB of at least 200 %, a Mooney viscosity of from 30 to 50 ML1+4, and a scorch time (t10) of at least 20 minutes.

[0011] Embodiments of the present invention will now be described in detail in conjunction with the accompanying drawings:

Fig. 1 is a cross sectional view of a tyre according to the present invention;
Fig. 2 is a cross sectional view of the bead portion thereof;
Fig. 3 is a diagram for explaining an average radius of curvature;
Fig. 4 is a cross sectional view of another example of the bead apex;
Fig. 5 is a cross sectional view of still another example of the bead apex; and
Figs. 6(A) and 6(B) are cross sectional views of a bead portion for explaining the prior art.

[0012] In Fig. 1, the tyre 1 comprises a tread portion 2, a pair of sidewall portions 3, a pair of bead portions 4, a toroidal carcass 6 extending between the bead portions 4, and a belt 7 disposed radially outside the carcass 6 in the tread portion 2.

[0013] In this embodiment, the tyre 1 is a heavy duty tubeless radial tyre for trucks and buses. Fig. 1 shows a normal state in which the tyre 1 is mounted on its standard rim J, inflated to standard inner pressure and not loaded. The standard rim is the "standard rim" specified in JATMA, the "Measuring Rim" in ETRTO, the "Design Rim" in TRA or the like. The standard pressure is the "maximum air pressure" in JATMA, the "Inflation Pressure" in ETRTO, the maximum pressure given in the "Tyre Load Limits at Various Cold Inflation Pressures" table in TRA or the like. However, in the case of a passenger car tyre, 180 KPa should be used as the "standard pressure".

[0014] The belt 7 comprises at least two crossed plies of parallel cords. For the belt cords, steel cords and organic fibre cords, e.g. rayon, nylon, aromatic polyamide and the like can be used. In Fig.1, the belt 7 is composed of four plies: a radially innermost ply 7a of cords laid at an angle of from 50 to 70 degrees with respect to the tyre equator C, and second to fourth plies 7b, 7c and 7d of cords laid at a small angle of not more than 30 degrees with respect to the

tyre equator C.

[0015] The carcass 6 comprises at least one ply 6a of cords arranged radially at angles in the range of from 70 to 90 degrees with respect to the tyre equator C. For the carcass cords, steel cords are preferably used but organic fibre cords of nylon, rayon, polyester, aromatic polyamide, and the like can be used.

[0016] In this embodiment, the carcass 6 comprises a single ply 6a of steel cords arranged radially at substantially 90 degrees with respect to the tyre equator C.

[0017] The carcass ply 6a extends between the bead portions 4 through the tread portion 2 and sidewall portions 3, and is turned up in the bead portions 4 from the axially inside to the outside of the tyre so as to form a turnup portion 6B in each bead portion 4 and a main portion 6A extending therebetween.

[0018] As shown in Fig. 2, an upper part 6B1 of the turnup portion 6B adjoins the main portion 6A to form an adjacent region G in which the turnup portion 6B and the main portion 6A are substantially parallel with each other.

[0019] Further, on the radially inner side of the adjacent region G, there is formed a space Y which is defined as surrounded by the remaining lower part 6B2 of the turnup portion 6B and the main portion 6A and which has a cross sectional shape like a water-drop.

[0020] In the adjacent region G, a thickness of rubber between the carcass cords of the main portion 6A and those of the turnup portion 6B is set in the range of from 0.15 to 4.5 times, preferably 1.3 to 3.5 times the maximum diameter of the carcass cords, whereby shear force therebetween can be mitigated and separation failures can be effectively prevented.

[0021] At least in the adjacent region G, the main portion 6A is substantially straight, and preferably, this straight part extends to a position lower than the rim flange (Lf) or lower than a centre of the waterdrop-shaped space Y.

[0022] The inclination angle α of the straight part is in the range of from 25 to 45 degrees with respect to the tyre equatorial plane C.

[0023] As to the turnup portion 6B, on the other hand, a part immediately radially inside the region G is curved concavely.

[0024] In the above-mentioned space Y, a bead-apex 5 is disposed. In Fig.2, the space Y is filled with only the bead apex 5. In Fig.4, the space Y is filled with the bead apex 5 and a reinforcing cord layer 8. In Fig.5, the space Y is filled with the bead apex 5 and a bead core 20.

[0025] The bead-apex 5 is made of a hybrid material which is compound from rubber, synthetic resin, and short fibre.

[0026] For the rubber, one of or a combination of natural rubber (NR), isoprene rubber (IR), styrene butadiene rubber (SBR), butadiene rubber (BR), isobutylene-isoprene rubber (IIR), nitrile rubber (NBR), and ethylene propylene rubber (EPDM) can be used.

[0027] For the synthetic resin, phenol-terpene base resin (e.g., SP1068 produced by Nippon Shokubai Co., Ltd.), petroleum base hydrocarbon resin (e.g., Escorets 1102 produced by Exon Kagaku), and the like can be used.

[0028] For the short fibre, organic short fibre, e.g. nylon, polyester, rayon, aromatic polyamide and the like can be suitably used. Preferably, the average diameter thereof is 0.01 to 0.20 mm and the average length is 1.0 to 10.0 mm. Monofilaments which are not engaged with each other are preferably used. If fibres or filaments which are twisted and thus engaged with each other are used, the fibres rub against each other and durability tends to be decreased. Further, it is preferable that the surface of the short fibre is treated to improve adhesion to rubber, for example, dipping into a fluid such as RFL. The proportion of the short fibre is preferably 3 to 15 parts by weight with respect to 100 parts by weight of the rubber. Organic short fibres are preferably used, but metal (e.g. steel) fibres may be used.

[0029] Further, the hybrid material may also include various additives such as vulcanising agent, reinforcing agent, age resistor, vulcanisation accelerator, auxiliary vulcanisation accelerator, vulcanisation retarder, plasticizer and the like.

[0030] For the vulcanising agent, sulfur can be used.

[0031] For the reinforcing agent, carbon black, silica, clay, aluminum hydroxide, calcium carbonate and the like can be used.

[0032] For the age resistor,

imidazoles such as 2-mercaptobenzimidazole;
amines such as phenyl-α-naphthylamine,
N,N'-di-β-naphthyl-P-phenylenediamine,
N-phenyl-N'-isopropyl-P-phenylenediamine;
phenols such as di-t-butyl-P-cresol,
styrenated phenol; and the like can be used.

[0033] For the vulcanisation accelerator,

inorganic accelerator such as hydrated lime,
magnesium oxide,
titanium oxide,
litharge (PbO), and

organic accelerator, e.g.
thiuram-base vulcanisation accelerator such as tetramethylthiuramdisulfide and tetramethylthiurammonosulfide;
dithiocarbamates such as zinc dibutyldithiocarbamate, zinc diethyldithiocarbamate, sodium dimethyldithiocarbamate, tellurium diethyldithiocarbamate;
thiazoles such as 2-mercaptobenzothiazole, N-cyclohexyl-2-benzothiazolesulfenamide;
thioureas such as trimethylthiourea, N,N'-diethylthiourea;
and the like can be used.

[0034] For the auxiliary vulcanisation accelerator,
metal oxide such as hydrozincite;
fatty acid such as stearic acid, oleic acid, cottonseed fatty acid;
and the like can be used.

[0035] For the vulcanisation retarder,
aromatic organic acid such as salicylic acid, phthalic anhydride, benzoic acid;
nitroso compound such as N-nitrosodiphenylamine, N-nitroso-2,2,4-trimethyl-1,2-dihydroquinone, N-nitrosophenyl-β-naphthylamine;
and the like can be used.

[0036] For the plasticizer, paraffin-base oil, naphthene-base oil, aromatic-base oil and the like can be used.

[0037] In order to improve rubber flow during vulcanisation and also rubber scorching during extruding, the proportion of carbon black and the proportion of crosslinking agent are decreased as compared with conventional bead apex rubber.

[0038] Table 1 shows examples of the hybrid material for the bead apex.

Table 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rubber (parts by weight)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
HAF carbon (parts by weight)	80	100	50	50	50	50	50	50	50	50	50	50	50	50
Short fibre (parts by weight)	-	-	-	5	7	15	5	5	5	5	5	5	5	-
Material	-	-	-	Aramide	Aramide	Aramide	Nylon	Polyester	Aramide	Aramide	Aramide	Aramide	Aramide (multi)	
Average diameter (mm)	-	-	-	0.02	0.02	0.02	0.05	0.04	0.05	0.15	0.02	0.02	0.05	-
Average length (mm)	-	-	-	5	5	5	5	5	5	5	0.7	15	5	-
Synthetic resin *1	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Others (parts by weight)														
Age resistor *2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Stearic acid	2	2	2	2	2	2	2	3	3	3	2	2	2	2
Hydrozincite	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sulfur	3	3	3	3	3	3	3	3	3	3	3	3	3	5
Vulcanisation accelerator *3	2	2	2	2	2	2	2	2	2	2	2	2	2	3
Vulcanisation retarder *4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Mooney viscosity (ML1+4)	75	115	40	42	43	43	40	41	42	42	40	43	40	42
Scorch time t10 (minute)	15	12	19	20	21	20	20	21	20	21	21	22	21	8
100% modulus (MPa)	10	12	4	12	14	-	10	11	13	12	8	14	11	9
Tensile strength TB (MPa)	20	18	29	23	20	12	23	22	21	15	21	18	22	20
Cutting elongation EB (%)	250	170	490	250	210	70	260	250	230	140	280	150	230	220

*1 SP1068 resin produced by Nippon Shokubai Co., Ltd.

*2 "Knockluck 224" produced by Ouchi Sinko Chemical Industrial Co. LTD.

*3 "Knockseller NS" produced by Ouchi Shinko Chemical Industrial Co. LTD.

*4 "Sunguard" produced by Monsanto Company

* Vulcanising agent (sulfur) was mixed by means of open roll and others were mixed by means of Banbury mixer.

[0039] As can be seen examples No. 4 to 13 have excellent rubber flowing property and scorching resistance while maintaining high strength and rigidity. In examples No.6, 10 and 12, extensibility and strength are decreased because of too much short fibre. In example 10 the short fibres are too large in diameter and in example 12 they are too long. In example 11, because the average length of the short fibres is short, the rigidity is relatively low.

[0040] The bead-apex 5 has a 100% modulus of at least 10.0 MPa, a tensile strength TB of at least 10.0 MPa, an elongation E3 at breakage of at least 200%, a Mooney viscosity in the range of 30 to 50 ML1+4 and a scorch time (t10) more than 20 minutes.

[0041] The "100% modulus", "tensile strength", and "elongation at breakage" are measured in accordance with testing methods described in "Tensile Testing Method of Vulcanised Rubber" of Japanese Industrial Standard K-6251.

[0042] The "Mooney viscosity" and "scorch time (t10)" are measured at a temperature of 130 degrees C in accordance with the testing methods described in "Mooney viscosity test" and "Mooney scorch test" in "Unvulcanised Rubber Physical Testing Methods" of Japanese Industrial Standard K-6300. The smaller the "Mooney viscosity" value, the better the rubber flowing, and thus the better the processability. The "scorch time (t10)" is a time (minute) required until the value increases by 10 points. The longer the scorch time, the greater the resistance to rubber scorching, and thus the better the processability.

[0043] If the average diameter of the short fibre is less than 0.01 mm, or the average length is less than 1.0 mm, or the proportion of the short fibre is less than 3 parts by weight, then reinforcing effect is insufficient, and it is difficult to set the 100% modulus, tensile strength and breaking elongation within the above-mentioned range without increasing the carbon black content. In other words, it is difficult to obtain characteristics of high strength, high rigidity and excellent rubber flowing property and rubber scorching resistance.

[0044] If the average diameter of the short fibres is more than 0.20 mm, or the average length is more than 10.0 mm, then the bead-apex is liable to be broken from the short fibre. If the proportion of the short fibre exceeds 15 parts by weight, then the hybrid material becomes too hard, and the strength decreases unexpectedly.

[0045] The above-mentioned compounding materials are melted during vulcanisation, and strong and a rigid polymer-alloy of rubber, resin and short fibres is formed. As a result, it becomes possible to obtain the required properties without using a conventional bead core.

[0046] The radially outer end 5e of the bead-apex 5 or the above-mentioned radially inner end of the adjacent region G is disposed at a height L1 in the range of from 1.2 to 3.0 times the height Lf of a flange Jf of a standard wheel rim J, each measured from a bead base line BL. The "bead base line BL" is a tyre axial line extending through a radial height corresponding to the diameter of the wheel rim. If the height L1 exceeds 3.0 times the height Lf, the effect of improving the bead durability can not be obtained. If the height L1 is less than 1.2 times the height Lf, it is difficult to set the height L1 at such a low value in producing the tyre and voids are liable to occur after vulcanisation.

[0047] The length L of the adjacent region G of the carcass ply is set in the range of from 0.5 to 5.0 times the maximum bead-apex width BW which is the axial distance between the axially innermost point Q1 and the axially outermost point Q2 thereof. If the length L is less than 0.5 times the width BW, the bead durability is decreased. If the length L exceeds 5.0 times the width BW, the bead durability can not be improved any more, and further as the ply edge of the turnup portion 6B is positioned in the sidewall portion 3, poor appearance and ply edge separation are liable to occur in the sidewall portions 3. Furthermore, the weight is increased.

[0048] In the examples shown in Fig.2 and Fig.4, as shown in Fig.3, a radially inner side 5i of the bead-apex 5 is defined by a radially-inwardly-swelling curve extending along the carcass ply 6a. The average radius R of this curve is set in the range of from 0.19 to 0.41 times the bead apex height L1. If the radius R is less than 0.19 times the height L1, it is difficult to smoothly bend the carcass ply and the cord arrangement is liable to be disturbed. If the radius R is more than 0.41 times the height L1, a springing-back force increases, and voids are liable to occur. The "average radius R" is defined as the radius of a circle passing through three points Q1, Q2 and Q3: the axially innermost point Q1, the axially outermost point Q2 and the radially innermost point Q3. The above-mentioned inner side 5i is defined as extending from Q1 to Q2.

[0049] Fig.4 and Fig.5 show examples suitable for hard use.

[0050] Fig.4 shows a modification of the above-explained bead portion shown in Fig.2. In this example, a reinforcing cord layer 8 is disposed in the centre of the bead-apex 5. The reinforcing layer 8 is made of circumferentially continuously extending cords 8A. For the cords 8A, high-modulus organic fibre cords such as aromatic polyamide fibre cords or steel cords are preferably used. In Fig.4, the reinforcing layer 8 is composed of a single ply of cords 8A arranged side by side in the axial direction. It is however also possible to make this layer 8 in a two-ply structure. In the case of a single-layered structure, the reinforcing layer 8 is formed by spirally winding a cord 8A several times. In the case of a multi-layered structure, it can be formed not only by spirally winding one or more cords but also by winding a strip of rubberised parallel cords 8A.

[0051] Fig.5 shows still another example of the bead portion, in which a bead core 20 is disposed radially inside a bead-apex 5A. The carcass ply 6a is turned up around the bead core 20. The bead-apex 5A in this example has a substantially triangular cross sectional shape tapering radially outwards from the bead core 20. The bead core 20 is

formed by compactly coiling a steel wire dozens of times whereas the cord in the reinforcing layer 8 is wound relatively loosely. In the present invention, even if the spring-back force of the turnup portion during vulcanisation is strong owing to the presence of the bead core 20, as the bead-apex 5 when uncured has low rubber viscosity and an excellent rubber flowing property, the bead-apex 5 flow smoothly near to the outer end 5e. Thus, the occurrence of voids is effectively controlled.

Comparison Tests:

[0052] Heavy duty radial tyres of size 11R22.5 were made and tested for bead durability, bead strength, and tyre weight.

Bead durability test:

[0053] Each test tyre mounted on a standard wheel rim of 8.25x22.5 and inflated to an inner pressure of 1000 kPa was run on a tyre testing drum at a speed of 20 km/h with a load of 9000 kgf. Running was stopped when visually observable damage occurred, and a ratio Li/Lo between a distance Li at which the damage occurred and a full running distance Lo of 10,000 km was obtained. In Table 2, the ratio Li/Lo is indicated by an index based on the prior art tyre being 100. The larger the value, the better the bead durability.

Bead strength test:

[0054] Each test tyre mounted on a standard wheel rim of 8.25x22.5 was filled with water and the pressure was increased. The pressure at which the bead apex was ruptured was measured. The pressure is indicated by an index based on the prior art tyre being 100. The larger the value, the higher the bead strength.

Tyre weight:

[0055] The tyre weight is indicated by an index based on the prior art tyre being 100.

[0056] In the test tyres, the carcass was composed of a single ply of steel cords (3x0.17+7x0.20) arranged radially at 90 degrees with respect to the tyre equator at a cord count of 21 (per 5 cm at the tread central). The belt was composed of four plies of steel cords (3x0.20+6x0.35) laid at +67, +18, -18 and -18 degrees (from inside to outside) with respect to the tyre equator at a cord count of 26 (per 5 cm).

[0057] Other specifications of the test tyres and test results are shown in Table 2.

Table 2

Tyre	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	C5	C6	C7	Prior
Bead apex																						
Material No.	5	5	5	5	5	5	5	4	4	4	4	4	4	4	8	8	8	8	8	8	8	1
Radius R (mm)	7.5	10.3	7.5	7.5	7.5	7.5	4.75	7.5	10.3	7.5	7.5	7.5	7.5	4.75	7.5	10.3	7.5	7.5	7.5	7.5	4.75	9.74
Height L1 (mm)	25	25	32	32	12.7	25	25	25	25	32	32	12.7	25	25	25	25	32	32	12.7	25	25	36
R/L1	0.3	0.41	0.3	0.3	0.6	0.3	0.19	0.3	0.41	0.3	0.3	0.6	0.3	0.19	0.3	0.41	0.3	0.3	0.6	0.3	0.19	0.27
Width BW (mm)	15	15	15	15	15	15	12	15	15	15	15	15	15	12	15	15	15	15	15	15	12	12
Rim flange height Jf (mm)	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
L1/Jf	2	2	2.5	2.5	1	2	2	2	2	2.5	2.5	1	2	2	2	2	2.5	2.5	1	2	2	2.83
Length L (mm)	60	60	7.5	6.5	60	76.5	60	60	60	7.5	6.5	60	76.5	60	60	60	7.5	6.5	60	76.5	60	60
L/BW	4	4	0.5	0.43	4	5.1	5	4	4	0.5	0.43	4	5.1	5	4	4	0.5	0.43	4	5.1	5	5
Reinforcing layer	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*2
Test results																						
Void	Non	Present	non	non	non	non	non	non	Pre-sent	non	non	non	non	non	non	Pre-sent	non	non	non	non	non	non
Bead durability	150	110	120	80	-	150	-	145	108	110	80	-	145	-	135	105	110	70	-	140	-	100
Bead strength	110	110	110	110	110	110	110	108	108	108	108	108	108	108	103	103	103	103	103	103	103	100
Tyre weight	96	95	94	94	-	105	-	96	95	94	94	-	105	-	96	95	94	94	-	105	-	100

*1: Fig.4, single layer of eight turns' steel cord

*2: Conventional bead core shown in Fig.6(B), coiled steel wire was used.

[0058] As described above, in the pneumatic tyre according to the present invention, the bead apex is improved in the rubber flowing property and scorching resistance (processability) as well as the strength and rigidity. Therefore, the occurrence of voids can be effectively controlled without increasing the height of the bead apex. Thus, the bead durability and tyre weight can be improved.

[0059] The present invention can be suitably applied to heavy duty tyres, but it is also possible to apply to tyres for light tracks, passenger cars, motorcycles, and the like.

Claims

1. A pneumatic tyre comprising a tread portion (2), a pair of sidewall portions (3), a pair of bead portions (4), a bead apex (5) disposed in each of the bead portions (4), a carcass ply (6) extending between the bead portions (4) and turned up in each of the bead portions so as to wrap the bead apex therein, characterised in that the said bead apex (5) comprises a hybrid material which is compounded from rubber, synthetic resin and short fibre at least.

2. A pneumatic tyre according to claim 1, characterised in that said hybrid material has a 100% modulus of at least 10.0 MPa, a tensile strength of at least 10.0 MPa, a breaking elongation EB of at least 200 %, a Mooney viscosity of from 30 to 50 ML1+4, and a scorch time (t10) of at least 20 minutes.

3. A pneumatic tyre according to claim 1 or 2, characterised in that said short fibre has an average diameter of 0.01 to 0.20 mm and an average length of 1.0 to 10.0 mm, and the proportion of the short fibre is 3 to 15 parts by weight with respect to 100 parts by weight of said rubber.

4. A pneumatic tyre according to claim 1, 2 or 3, characterised in that said bead apex (5) has a cross sectional shape like a water drop, the radially inner side (5i) of which is curved, and tapers radially outwards of the tyre.

5. A pneumatic tyre according to claim 1, 2 or 3, characterised in that said bead apex has a cross sectional shape like a water drop, the radially inner side (5i) of which is curved, and tapers radially outwards of the tyre, and a reinforcing layer (8), which is made of an organic fibre cord or a steel cord extending continuously in the tyre circumferential direction, is embedded in the bead apex.

6. A pneumatic tyre according to claim 1, 2 or 3, characterised in that said bead apex (5A) has a triangular cross sectional shape which tapers radially outward of the tyre, and a bead core (20) is disposed immediately radially inside said bead apex.

Fig.1

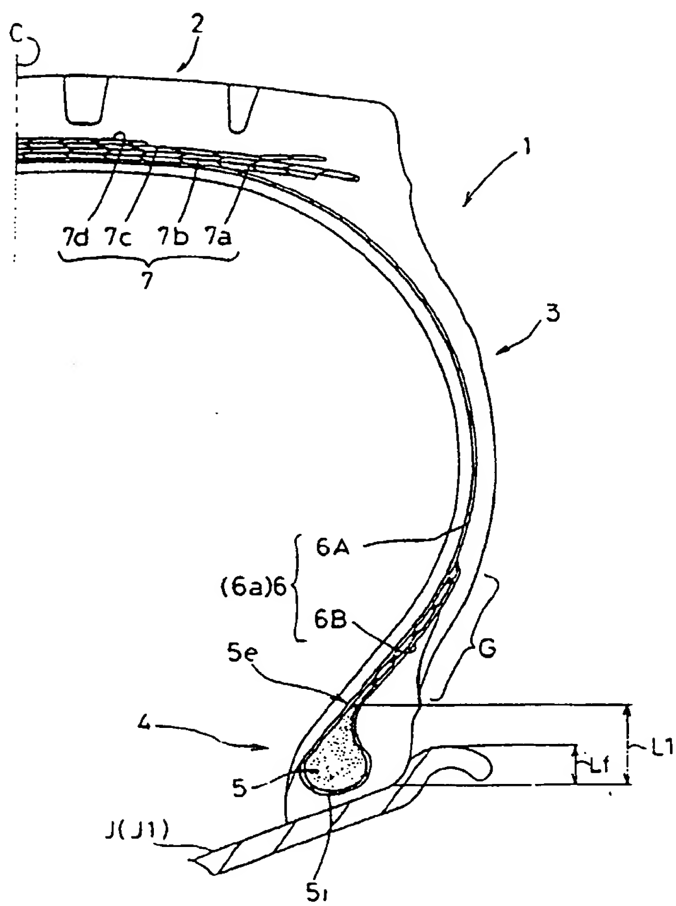


Fig.2

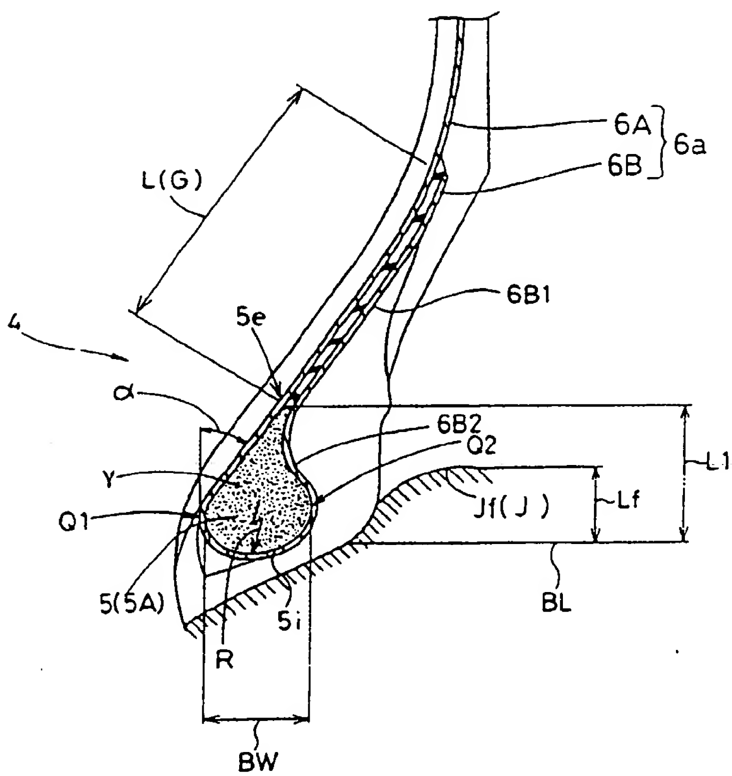


Fig.3

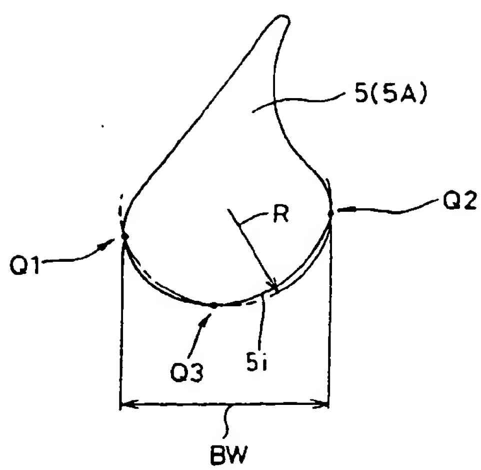


Fig.4

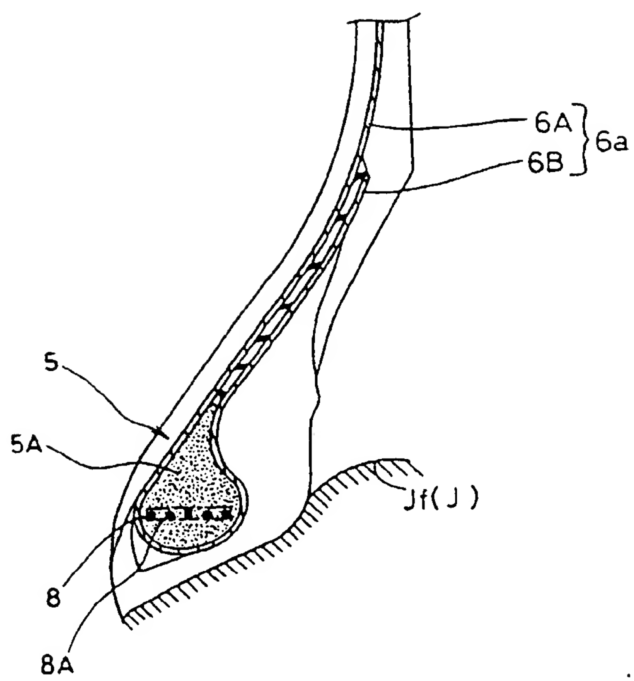


Fig.5

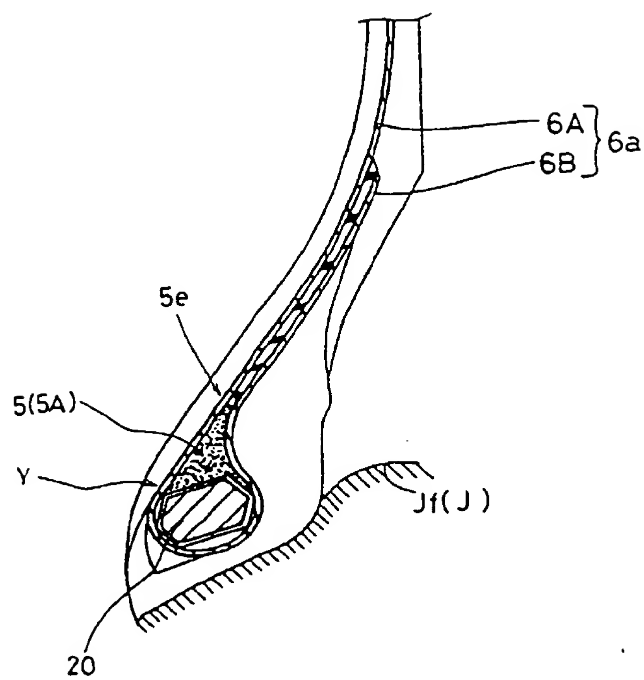


Fig.6(A)

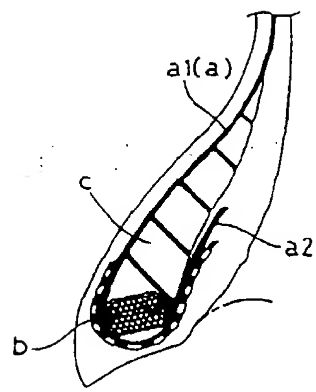
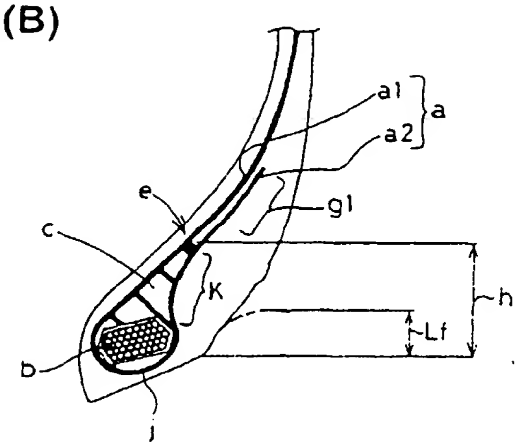


Fig.6(B)



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(71) Applicant: Sumitomo Rubber Industries Ltd.
Kobe-shi, Hyogo-ken (JP)

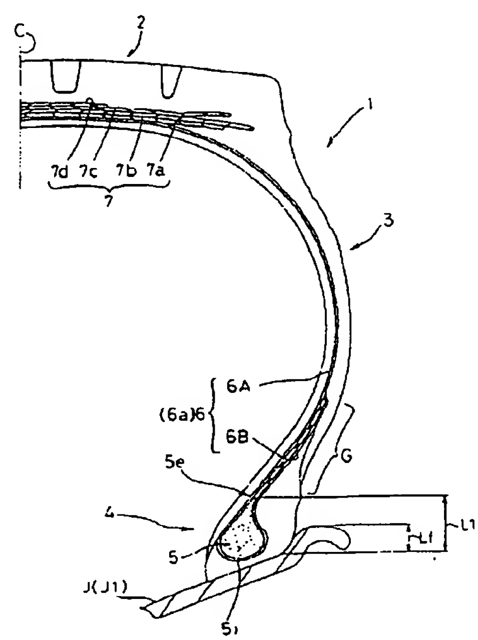
(72) Inventors:
- Ueyoko, Kiyoshi
Kobe-shi, Hyogo-ken (JP)
- Minagawa, Yasuhisa
Akashi-shi, Hyogo-ken (JP)

(74) Representative: Stewart, Charles Geoffrey
Technical,
Dunlop Tyres Ltd.,
Fort Dunlop
Erdington, Birmingham B24 9QT (GB)

(54) **Pneumatic tyre**

(57) A pneumatic tyre comprises a bead apex (5) disposed in each bead portion (4), and a carcass ply (6) extending between the bead portions and turned up in each bead portion (4) so as to wrap the bead apex (5) therein, the bead apex (5) being made of a hybrid material which is compounded from rubber, synthetic resin and short fibre at least. Preferably, the short fibre has an average diameter of 0.01 to 0.20 mm and an average length of 1.0 to 10.0 mm, and the proportion of the short fibre is 3 to 15 parts by weight with respect to 100 parts by weight of the rubber. The hybrid material has a 100% modulus of at least 10.0 MPa, a tensile strength of at least 10.0 MPa, a breaking elongation EB of at least 200 %, a Mooney viscosity of from 30 to 50 ML1+4, and a scorch time (t10) of at least 20 minutes. Optionally, a reinforcing cord layer (8) embedded in the bead apex (5) or a bead core (20) disposed immediately radially inside the bead apex is used.

Fig.1



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Place of search	Date of completion of the search	Examiner
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